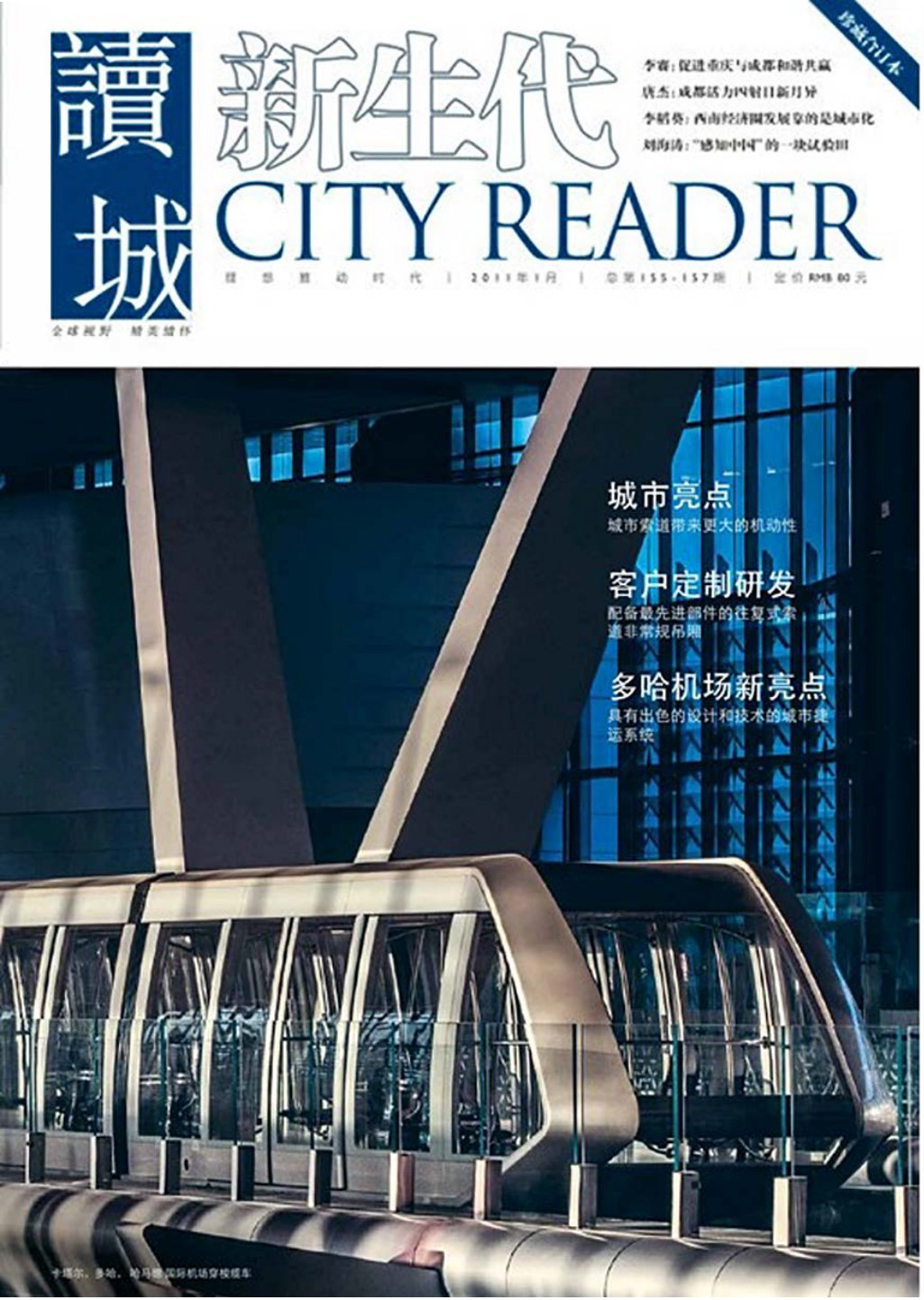


Urban Design for Sustainability:
A case study of the carbon-neutral "Masdar City" in Abu Dhabi

Jiayi Jin

1. INTRODUCTION

Having researched various topics covered in the 321 History and Theory lecture series, and having read through some of the recommended books - namely Jan Gehl's Cities for People, Rob Krier's Urban Space, Gordon Cullen's Townscape and The Collage city (and some others), I encountered many ideas that I find highly interesting. This, ironically, rendered it quite hard for me to choose a single topic for my research report. After thorough consideration, however, I have decided to focus on a very contemporary scheme - in an anticipation of being able to identify the influence of some of these theories in my topic and examining how they can be relevant to urbanism in the 21st century.

With sustainability being one of the most pressing issues of our age (sometimes seemingly being almost elevated to the status of a zeitgeist), I have decided to analyze a development which has this very idea in its heart. An obvious choice offered itself: Masdar city - the only ***holistic*** and not (yet) failed attempt to recreate a truly *sustainable* community (Yee, 2012). Laying focus on the design elements of this development, I have decided to compare it to another, much older, city of the Arabic world - Fes, which is a place I have visited personally. Fes is an example of a city from which the architects of Masdar took many of the ideas for their design, as they openly admit, and as I shall explore later.

Research methods

Considering that the development is very recent and still under construction, there is not much extensive printed material available. As the main source of my research, therefore, I have used a variety of internet sources - starting with the developers' and the architects' official websites; including numerous articles analyzing the development and reviewing it. In addition to this, I have used the Architects' Journal and the Architectural Record magazines, along with various electronic booklets about the city. Additional material was researched to get an insight into the political and economical situation of Abu Dhabi and finally the history and theory of traditional Arabic architecture, especially in the cities of Morocco.

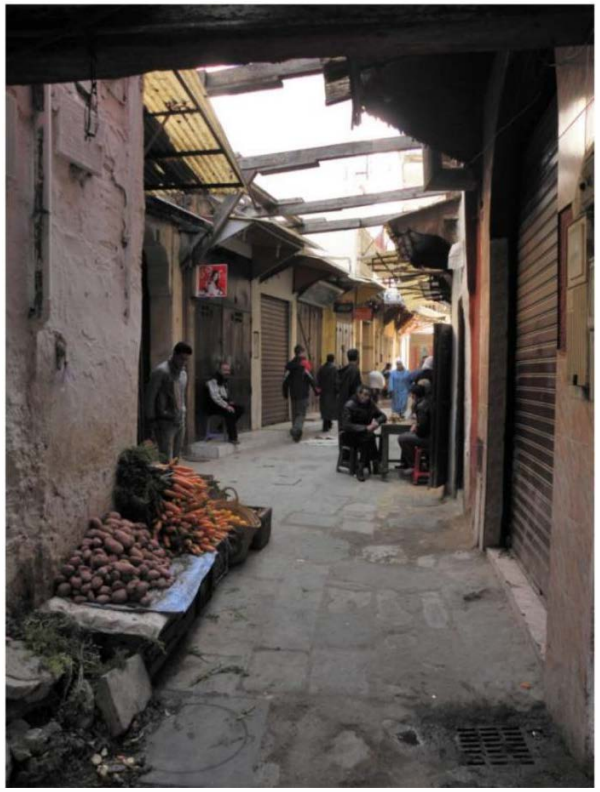


Figure 1: A typical street in the medina of Fes;

Buildings are being pushed close together, providing shaded area for the solely pedestrian traffic, encouraging street life and lingering activities - such as retail and gathering

The Old and Traditional

Many western tourists visiting traditional Arabic cities are enchanted by the atmosphere these cities offer. An example of such place is the old city of Fes in Morocco, with its walled medina. The medina is a historic city centre consisting of a labyrinth of twisting narrow streets (0,6 - 5m wide) ("The Moroccan Medina", 2002), along which compact low-rise buildings (up to 4 stories) provide natural shading and intimacy, creating a very specific atmosphere, that can be found only in this region and type of climate.

The densely populated area houses a lively and diverse community of people (the population estimated at 156.000 across the area of 300 hectares) ("The Moroccan Medina", 2002) – with functions such as retail and manufacture (consisting mainly of traditional crafts) integrated in the lifestyle and the fabric of the city[1]. Because of the narrow streets, no car traffic is allowed in the medina, creating a fully walkable environment and encouraging activities taking place in the streets. In the case of Fes, the alternative transport to foot are mainly donkeys, used for transportation of cargo.

The city of Fes is one of the 4 cities in Morocco with an *imperial* status and the country's former capital. Fas el Bali, housing the medina is a UNESCO World Heritage site; the medina being believed to be the world's largest contiguous car-free urban area (Crawford, 2003). It houses many important historical buildings - a notable example of which is The University of Al-Karaouine, founded in AD 859 - the (disputably) oldest continuously functioning university in the world. The university's adjacent Kairouyine mosque is one of the oldest and largest in Africa ("*Kairaouine Mosque, Fes",* 2009). The city has also been called the 'Mecca of the West' and the 'Athens of Africa' (Souames, 2011).

[1] The estimated number of retail businesses in the medina is 10.539, most of them being small family businesses with retail spilling onto the street. ("The Moroccan Medina", 2002)

The New and Sustainable

Despite the magic of this place and its many sustainable attributes ("The Moroccan Medina", 2002), Fes - along with other medieval Arabic cities - has serious problems arising from the very core of its design principles (Sendin, 2011). Overpopulation, congestion and social conditions are the most severe ones (Radoine, 2008). An effort to combat these problems is represented by the Fes-Medina Rehabilitation Project (*"Fes Medina Rehabilitation Project", 2009*), launched in the late 90s. In opposition to this, however, stands an entirely different and radical approach towards creating an urban utopia: to design a new, highly sustainable city from scratch.

The question to be asked here is - Could the positive aspects of a community such as the Medina be extracted and reinvented in an entirely new fashion, relevant to the 21st-century? Relying on the implementation of rational planning, the British architectural giant, Sir Norman Foster and the investors behind the Masdar city development certainly believe so. The Masdar city, located on the outskirts of Abu Dhabi - the capital of The United Arab Emirates, is an ambitious attempt to offer a glimpse into what the cities of future might look like (according to Foster) (Foster, 2011), while promoting the values of sustainability.

In my report, I will examine how and to how successfully this is achieved, laying stress on the elements this city borrows from the developments of the past, particularly the city of Fes, mentioned earlier. I will start with some background and driving ideas behind the development, continuing with analysis of the design of the city itself and finally concluding with the outcome of these efforts so far - analyzing to what extent the objectives have been met and what are the implications in a larger context.

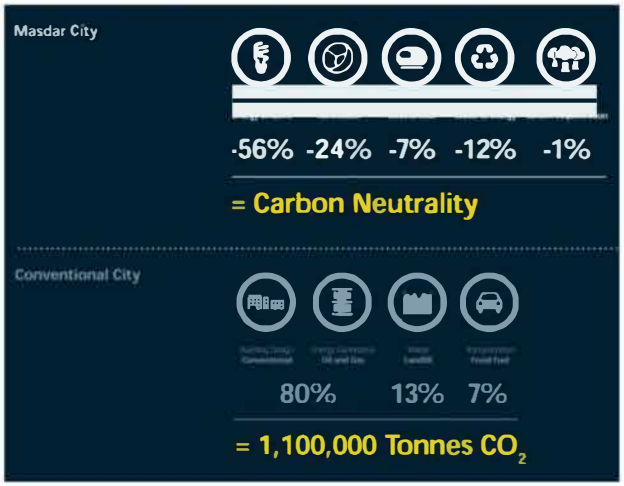


Figure 2: The planned energy footprint of Masdar city, compared to a conventional city

Figure 3: One Planet Living principles

2. MASDAR - CITY OF THE FUTURE

The Big Idea - A utopia?

'Truly sustainable' - this is the label that I attributed to Masdar city in the introduction. However, this is a very tricky term and I believe that firstly it deserves some space and attention to be defined and analyzed what the term actually represents. According to Masdar city website:

"(...) more than half the world's population now lives in cities, a percentage that is expected to rise to 70% by 2030, and (...) cities today are responsible for over 70% of global CO_2 emissions." (masdarcity.ae)

Dr. Zuberi, a clean-tech material expert further states:

"Global warming would bring a disruption of geological, climate and natural cycles that would put the lives of billions of people at risk (...). It has become obvious that our fragile earth cannot continue to depend on fossil fuels and sooner or later, a sustainable energy source must be found." (Zuberi, 2008)

These statements highlight the importance of sustainability nowadays, and the especial responsibility of the cities - which is an ethos adopted by the privately owned, government subsidiary company Masdar[2], the city's developer (masdarcity.ae). As the company claims:

"Carbon neutrality is at the forefront of public consciousness. Individuals, businesses, states and even countries are pledging to dramatically reduce carbon emissions, recycle waste and offset the remainder. The result? Ideally, zero net carbon emissions - and a chance to help arrest the progress of climate change." ("Masdar City: The world's first carbon-neutral city", 2009).

Apart from stressing the ever-increasing importance of sustainability, however, the case of Masdar strives to be much more than that. With the design imperatives of *synergy, mobility, energy, and quality of life* ("Masdar City: Abu Dhabi Green Clean Tech Project") the project developers have chosen to implement the One Planet living principles (see Figure 3).

[2] also known as ADFEC - Abu Dhabi Future Energy Company

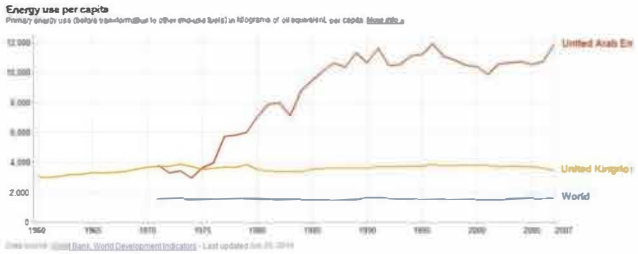


Figure 4: A diagram illustrating the rapid increase in the energy use per capita in the UAE, compared to the UK and world average

These standards (particularly 8 to 10) illustrate how sustainability in the minds of the developers is firmly connected with quality of life and creation of 'an attractive place to live' (masdarcity.ae) - as part of the strategy to make the ideals alluring to the wider public. This, of course, is an implication of necessity to some extent; with the money of the investors at stake, and the project's success depending on the number of individuals and businesses the scheme will attract. Part of this effort can undoubtedly also be seen as a 'facelift' to the image of the oil economy of the Emirates, which I will explore presently.

The setting - A green-minded society or a dirty oil economy?

"The world today runs on fossil fuel (...). Middle East has been endowed with vast reserves of oil and gas which have been the primary source of the economy of the region for the past few decades. (...) This natural resource has brought a boom to Middle East economies. With oil prices above $100 per barrel, Abu Dhabi (...) collects oil revenue greater than $200 million a day, giving it the 2nd highest GDP in the region (after Qatar)." (Zuberi, 2008)

This sudden influx of wealth over the past decades triggered a construction boom in Abu Dhabi - resulting in *Plan Abu Dhabi 2030* being published, expecting the city quadrupling in size (Murray, 2008, p.23). In contrast to the vast advantages this provides for the local economy - its global impact is somewhat different - considering the emissions embodied in all the construction and increased transport. At the moment, *"Abu Dhabi is estimated to have a CO2 emissions intensity of 34 metric tons per capita, compared to a global average of 4.3 metric tons per capita"* (Zuberi, 2008), which is an alarming figure.

As an attempt to offset this, comes the *"the dream of Sheik Mohamed bin Zayed Al Nahyan — the Crown Prince of Abu Dhabi",* whose emirate possesses *"the world's richest sovereign wealth fund, worth over $700 billion."* ("Dubai World and Masdar: A Tale of Two Cities", 2009). Its name is Masdar, meaning the 'source' in Arabic (masdarcity.ae). Among some of the early successes of the scheme can be included the fact that this 'dream' has been backed by the International Renewable Energy Agency (IRENA), which is setting up its headquarters here, along with some other international companies, including Siemens, which will establish its Middle East headquarters here (masdarcity.ae).

In order to help attracting potential investors, the Emirates government has also assigned some exceptional legislation to this city, including 0% import tariffs and taxes, no restrictions on capital movements, profits, quotas or amount of currency and 100% foreign ownership (masdarcity.ae). With these economical factors and social objectives in mind, I will now examine the actual design for the city in some detail.

Figure 5: The Fes medina - aerial view; displaying the emergent pattern of the development

Figure 6: Masdar master plan by Foster, based on a rational grid

The Master plan

In contrast to the Medina of Fes, which has developed through emergent processes during the course of centuries (since its founding in 808) (Darles, 1996), the Masdar development is centrally planned, based on a master plan designed by the British firm Foster & Partners. At full build-out by 2025, the city, occupying a 6 square km site is expected to have 40.000 residents and 50.000 commuters (masdarcity.ae).

How does this plan incorporate sustainability? From the initial concept, stress was laid on the passive design elements, which the designers acknowledged as the most effective and the cheapest ones ("Exploring Masdar City", 2010, p.5) - such as the city's orientation and overall form. The numerous active systems implemented here - namely the smart energy grid, wastewater recycling, photovoltaics and geothermal energy (and many others) - come only later to supplement these, as the following pyramid diagram shows:

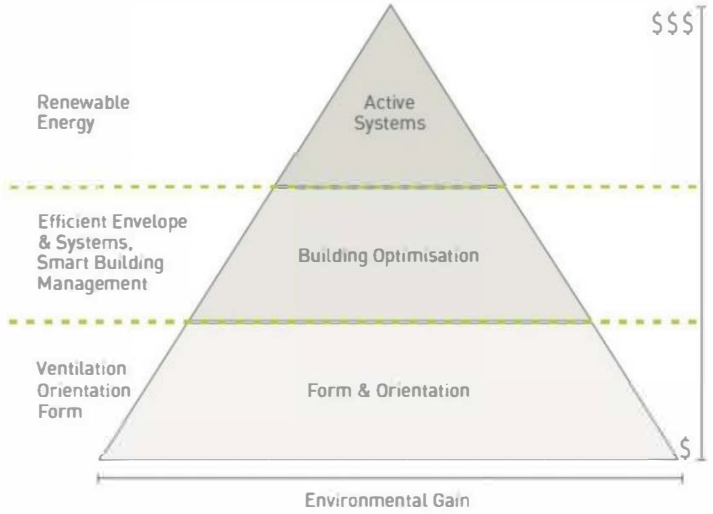


Figure 7: Sustainable systems hierarchy

Figure 8: The 45 m tall wind tower in Masdar city - capturing upper-level winds and directing them to the open-air public square at its base

Figure 9: A traditional wind tower in Dubai

Acknowledging the importance of the active design features - these, however, do not fall into the focus of this report and therefore I will not examine them in detail. I will focus instead on the bottom of the pyramid - which certainly starts with the orientation of the city's grid. The streets are laid out on a southeast-northwest axis (38 degrees counter-clockwise of the north axis) ("Exploring Masdar City", 2010, p.23), thereby providing some shading at the street level throughout the day, minimising thermal gain on building walls and facilitating the flow of cooling breezes through the city ("Exploring Masdar City", 2010, p.5).

Similarly to Fes, the narrow streets with low-rise buildings provide maximum shade on the streets and render a population density of 135 people per hectare ("Masdar City: Abu Dhabi Green Clean Tech Project"), compared to the estimated population density of 500 people per hectare in the medina of Fes (Crawford, 2003). In addition to this, the recesses of buildings' colonnades offer respite from the sun and planting together with water features help to significantly reduce the radiant temperature. Other vernacular devices, such as wind gates and a wind tower, are used to regulate the wind flow within the streets (Foster, 2011).

As Norman Foster puts it:

"(...) We studied the way animals adapt to and exploit their environment. Just as penguins huddle together for warmth in the Arctic, so camels huddle to create shade in the desert. In Masdar City, tall buildings will crowd together to provide shade in narrow walkways, opening into courtyards with fountains." (Foster, 2011)

Not only can these most simple devices be found throughout the animal kingdom - they have also been used in Arabic cities such as Fes long before modern sophisticated systems were available. To prove the efficiency of these measures, thermal scans have already shown that the streets of Masdar are up to 20 degrees cooler than downtown Abu Dabi (masdarcity.com). All of this makes the environment more pleasant and liveable, in an attempt to attract more street life and walking activity in the city.

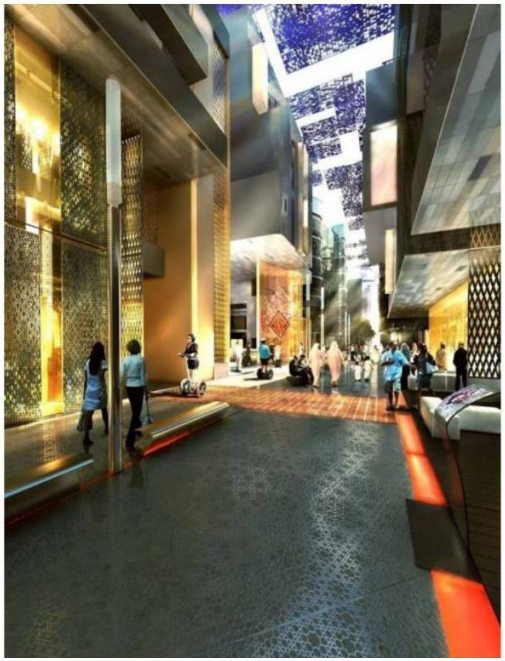


Figure 10: A shaded colonnade street in Masdar (artist's impression); notice how the inside of the buildings seems to flow into the outside

Figure 11: Dubai. A 100 km/h city.
Large buildings and little attention to detail offer little to enjoy.

Figure 12: Venice. A 5 km/h city.
It offers a wealth of experiences and sensory impressions.

Transport - The pedestrian city

In Fes, the lively outdoor life owes its existence mainly to the full restriction of cars in the medina. The designers have applied the same idea for Masdar - with the cars being stopped at the city's boundaries.

This also mirrors the increasing priority given by many modern city planners to the human sphere and non-vehicular slow-speed transport, as explored in Jan Gehl's book Cities for People. One of the examples of a city built primarily for fast vehicular traffic that Gehl criticizes in his book is, ironically, Abu Dhabi's 'glamorous' sister - Dubai. Approaches such as those employed here, according to Gehl, degrade the pedestrian realm in many cities nowadays (Gehl, 2010, p.58).

Without a visible vehicular traffic, the whole conception of the public realm changes - as is seen in Fes:

"Fez is a relatively relaxed city; there is time for everything. The retention of this classic sense of time can be attributed, in part at least, to the absence of motor vehicles in the medina. If you live in a city where you never have to run in order to catch something, or jump to avoid being hit by it, you are likely to have preserved a natural physical dignity which is not a concomitant of contemporary life; (...) So you see to it that you have time to do whatever you want to do; it is vulgar to hurry." (Sendin, 2011)

Naturally, a modern city could not function using solely pedestrian traffic and this is acknowledged by integrating what is called Personal Rapid Transport (PRT) into Masdar's infrastructure. The PRT is a system of *"electric-powered, automated, single-cabin vehicles that offer the privacy, comfort and non-stop travel of a taxi service, and the reliability and sustainability of a public transport system."* (masdarcity.ae) The PRT grid is designed to ensure that its stations are always within a walking distance (Elgendy, 2010). It will also provide connection to a central light rail system and Abu Dhabi's Metro. According to the city's master plan, *"no one will be more than 200 meters from essential facilities, including shops selling locally grown produce."* ("Masdar Plans World's First Green City", 2007).

The arteries of the system will be located underground, inside a 7m high slab which is supposed to run underneath the whole city[3] ("Exploring Masdar City", 2010, p.13). This carefully-designed system seems to be a relatively effective solution in dealing with the city's transportation problems, and is aiming to become as integral to its infrastructure, as the donkey traffic is in Fes.

[3] After the 2010 design review, this will apparently no longer be the case

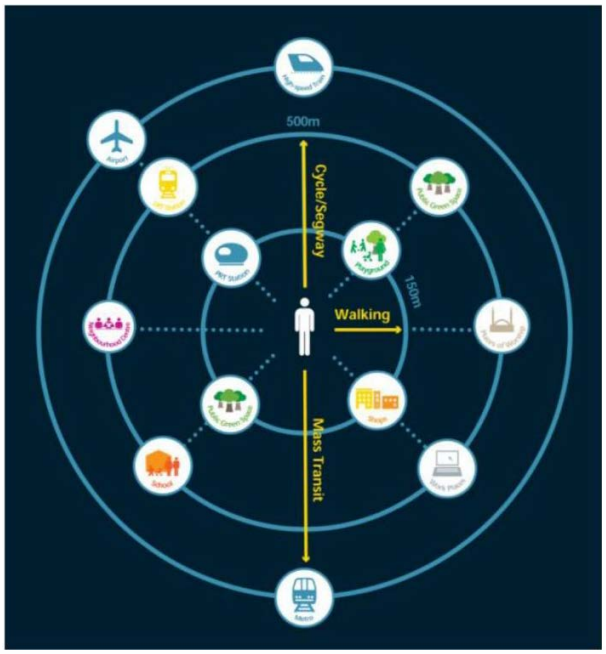


Figure 13: The distances to various amenities and types of transport in Masdar; the stress is on the most important ones being within a 200m walking reach

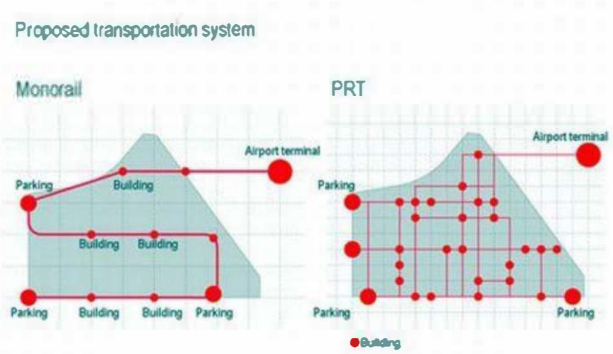
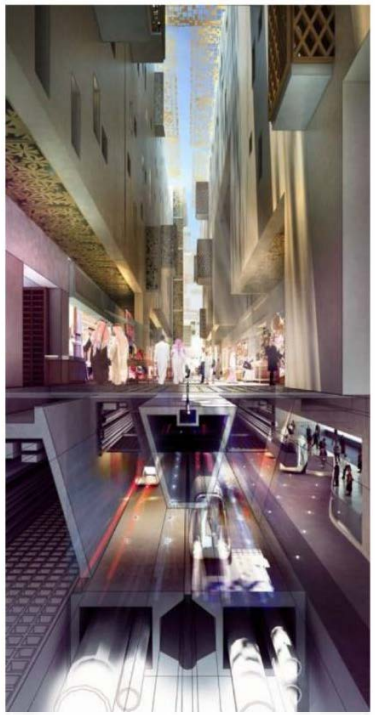


Figure 14: The hierarchy of the transport systems in the city



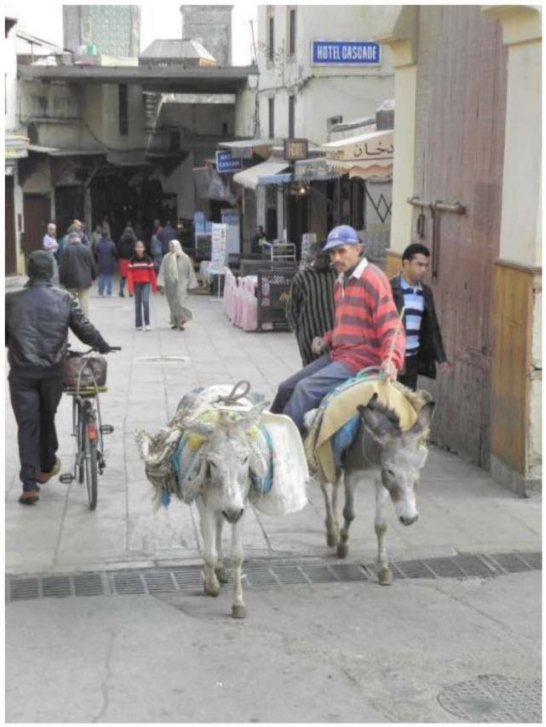


Figure 15: Masdar street section, showing the buried PRT system; Figure 16: donkey transport in Fes; 'There is time for everything'

The result can be compared to Disneyland, as Foster says:

"Disneyland is attractive because all the service is below ground. (...) We do the same here — it is literally a walled city. Traditional cars are stopped at the edges." (Ouroussoff, 2010)

Figure 17: The urban fabric of the medina of Fes - showing the street pattern and the relationships between the solids and the voids. Most buildings have internal courtyards.

Urban fabric - courtyards and parks

In order to provide a successful public realm, the relationship between the solids and voids becomes very important. The public space can be seen as a symbiosis of dynamic elements (streets) and static elements (squares and courtyards). Such pattern is obvious when looking at the plan of Fes - where the buildings, instead of appearing as 'objects' (as is the tendency in modern cities) (Kuma, 2008), stand back and merge into a continuous *fabric*, assuming the function of walls for *urban rooms* - as Camillo Sitte would describe it.

This is mirrored in Foster's statement:

"(..) It strikes me that what makes a city agreeable is actually not any one building. It is the way you get about, the public spaces, the streets, walkways, bridges, parks and squares." (Foster, 2011)

In the case of Fes -

"Although there is only one large public square there are plenty of small improvised squares created in the residual space of the irregular urban grid. Most of the socializing happens in the streets and in other public spaces such a s the mosque, the hammam and the marketplace." (Sendin, 2011) The function of the streets is for *"human interaction foremost and movement [is] secondary"* (Crawford, 2003)

The open spaces in Masdar are designed to be reminiscent of the traditional Middle-Eastern courtyards (Elgendy, 2010), employing neighbourhood level garden squares and urban plazas ("Masdar City: Abu Dhabi Green Clean Tech Project"), creating a "*loop of indoor and outdoor user-experiences*." ("Masdar City Continues To Make Progress On Sustainability Goals", 2009). In addition to this, the city's grid is pierced by two main 'green fingers' ("Exploring Masdar City", 2010, p.23) - brining the nature into the city and creating pleasant spaces for recreation. These *"arid vegetation landscapes create habitat for endangered species and feed air movement to public areas."* (aecom.com) The image of these green spaces can also be seen as a reference to the traditional Islamic garden:

Figure 18: A courtyard space in Masdar city - impression

Figure 19: Rendering of a space in the green finger
(the public realm Landscape Strategy was developed by AECOM)

"The Islamic garden is based on the Qur'anic image of the oasis turned into celestial paradise, a place of 'abundant water, fragrance and fruit trees... featuring lofty shaded places where the believers can sit in perfect peace and enjoy exquisite pleasures" (Kehagias, 2011)

In the case of Masdar, however, the concept of privacy the Fes riads (courtyard houses) are based on ("Moroccan Architecture", 2009) seems to be turned inside-out - making the gardens public and accessible, in accordance with the project's overall democratic ethos. This impression changes, however, if one applies the concept of this walled 'pleasure garden' to the whole city in itself, as will be touched upon in the following chapter.

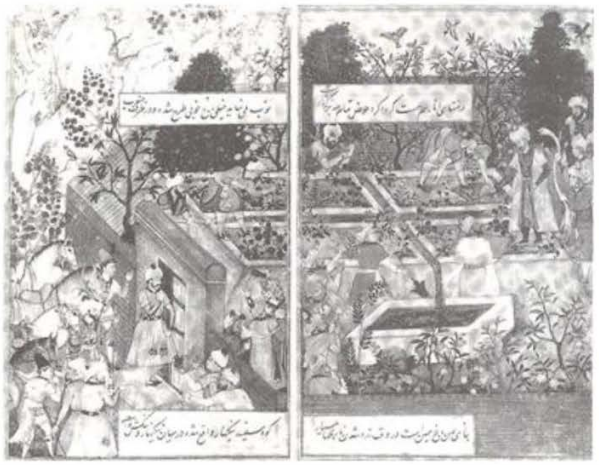


Figure 20: A miniature from the 17th century, showing the emperor Babur supervising construction of his walled garden

Figure 21: A typical Moroccan riad

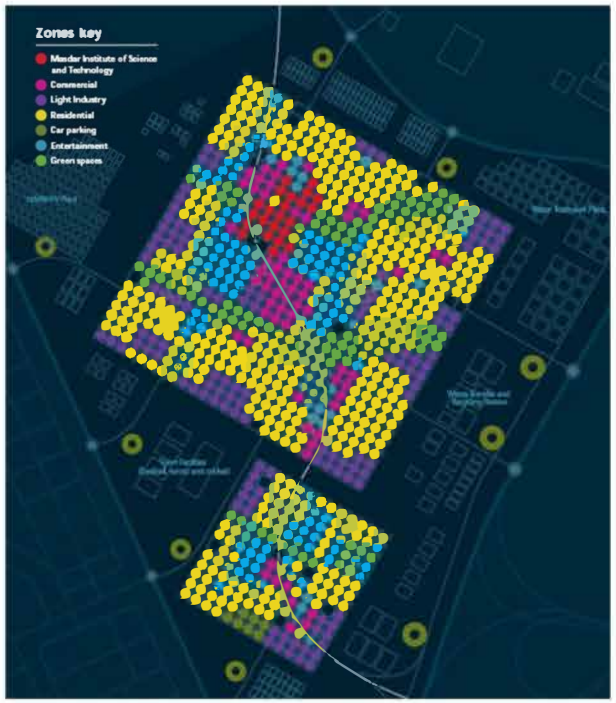


Figure 22: Zoning proposed by the city master plan

The community and the social structure - A 'playground' for the rich?

Integration and mixed-use are important for the success of the scheme - similarly to Fes, where: *"This reduces the travel distances greatly, making the use of a car unnecessary. Mixed-use results as well in a lively city, constantly in use and rich in social interaction."* (Sendin, 2011) *"Life is unified into a whole, rather than compartmentalised and separated according to modern Functionalist logic."* (Crawford, 2003)

Despite this, provisions have been made in the Masdar master plan, to account for several zones housing different functions (as shown in figure 24).

From this diagram it seems, however that effort has been made to disperse these functions as much as possible. Perhaps the biggest exception to this is the clustered Masdar Institute complex, lying in the heart of the city - in the place traditionally occupied by a marketplace square, a civic or a religious building. The institute is a postgraduate educational institution offering degrees in disciplines mainly related to engineering and information technologies (masdarcity.ae). This creates a constant reminder of what the development stands for, and corresponds to the effort of the Emirate to transform itself into a high-tech industrial and knowledge economy ("Dubai World and Masdar: A Tale of Two Cities", 2009), all in accordance to its Economic Vision 2030 plan (masdarcity.ae).

As the authors of Architect's Journal state, *"The stroke of genius in the Masdar concept is prioritising education as a route to global thought-leadership on renewable energy."* (Hartman, 2010, p.26) The institute is a key element in the ambition for Abu Dhabi to become a 'global centre of excellence' in the sustainable technologies category (masdarcity.com). Its role can perhaps be compared to the role of the University of Al-Karaouine in making Fes *"the spiritual, scientific, and cultural capital of Morocco"* (Radoine, 2008) (and perhaps a much larger part of the Arabic world in the past). The developer's ambition, in the case of Masdar, seems to be even greater, and more global-oriented.

Regardless of the degree of its internal integration, the whole development with its walls - in this case not serving for defence but to stop the desert winds (Elgendy, 2010) - creates a segregated community, with the mentality of a walled medina being strongly implemented here. In the case of the medina, the result is a ghetto for the poor, while in Masdar the risk is, on the contrary, of creating a ghetto for the rich (Ouroussoff, 2010).

3. CONCLUSION

Considering the development's numerous benefits and its downsides, there have been mixed views regarding its moral 'purity' and success so far. Because of the global financial crisis, there have been a design review in 2010 (Gunther, 2011) incorporating several changes - chiefly regarding the energy sources and transportation plan for the city, along with a budget cut and deadline extension. Despite all of this, the ambitious project still carries on, having completed the first part of phase I, and planned to be fully completed by 2025 (masdarcity.com).

Regarding the user experience, people who visited the completed part of the city so far witness that the atmosphere is truly unique - as stated by some of the visitors: *"It's supposed to have the feel of an old Arab village, and it works for me."* (Gunther, 2011). Based on this, it seems that the integration of the Old and the New has been quite successful, but only time will show how this will develop further and if the future cities will look anything like this.

It is, furthermore, questionable how this model can be adapted on a global scale, having to admit to the criticism concerning the scheme's suitability for large cities and different climates. Despite all of this, nonetheless, it is *"(...) the world's first comprehensive experiment in integrating the whole spectrum of green technologies at a city scale*" ("Dubai World and Masdar: A Tale of Two Cities", 2009) and the results will be undoubtedly instructive for the future course of our civilization.

LIST OF IMAGES

BIBLIOGRAPHY

Development & archtiect's official sites:

Masdar City: http://www.masdarcity.ae/en/

Masdar Institute: http://www.masdar.ac.ae/

Mott Macdonald: http://www.mottmac.com/projects/?id=185262

AECOM:
http://www.aecom.com/What+We+Do/Design+and+Planning/stories/Masdar+City

Internet articles & reviews of Masdar:

Elgendy, K. (2010, May 12). *Abu Dhabi's Masdar Headquarters: The First Positive-Energy Building in the Middle East.* Retrieved from http://www.carboun.com/sustainable-development/sustainable-design/masdar-headquarters-the-first-positive-energy-building-in-the-middle-east/

Foster, N. (2011, January 26). The city of the future: It's a story of camels, penguins and cars you don't drive. *Daily Mail.* Retrieved from http://www.dailymail.co.uk

Gunther, M. (2011, January 21). *A Photo Tour of Masdar City.* Retrieved from http://www.greenbiz.com/blog/2011/01/20/photo-tour-masdar-city

Kehagias, N. (2011). *Masdar City: A Heterotopia in the Desert*. Retrieved from http://www.nicholaskehagias.com/index.php?/writing/masdar-city/

Ouroussoff, N. (2010, September 25). In Arabian Desert, a Sustainable City Rises. *The New York Times*. Retrieved from http://www.nytimes.com

Vidal, J. (2011, April 26). Masdar City – a glimpse of the future in the desert. *The Guardian*. Retrieved from http://www.guardian.co.uk

Yee, A. (2012, April 15). Trailblazers on Masdar's frontier. *The National.* Retrieved from http://www.thenational.ae

Zuberi, B. (2008, April 8). *Masdar City: Not a showcase, but an 'Entrepreneurial Eco-system'*. Retrieved from http://www.dinarstandard.com/innovation/Masdar040608.htm

Dubai World and Masdar: A Tale of Two Cities (2009, December 7). Retrieved from http://www.getreallist.com/dubai-world-and-masdar-a-tale-of-two-cities.html

Masdar City: Abu Dhabi Green Clean Tech Project. Retrieved from http://www.2daydubai.com/pages/masdar-city.php

Masdar City Continues To Make Progress On Sustainability Goals. (2009, September 1). Retrieved from http://www.sincerelysustainable.com/buildings/masdar-city-continues-with-progress-and-lofty-sustainability-goals

Masdar City Masterplan Reviewed. (2010, February 20). Retrieved from http://www.carboun.com/sustainable-development/sustainable-design/masdar-city-masterplan/#more-127

Masdar City Master Plan Review Provides Progress Update (2010, October 10). Retrieved from http://www.reuters.com

Masdar Plans World's First Green City (2007, October 19). Retrieved from http://www.sustainablebusiness.com/index.cfm/go/news.feature/id/1497

Material on Islamic architecture & Fes:

Crawford, J. H. (2003). *Carfree Cities: Do We Need Them and Can They Work?* Retrieved from http://www.worldcarfree.net/conference/2003/transcripts.php

Darles, G. (1996, October). *The medina of Fez - crafting a future for the past.* Retrieved from http://findarticles.com/p/articles/mi_m1310/is_1996_Oct/ai_18826830/

Radoine, H. (2008, August). Urban Conservation of Fez-Medina: A Post-Impact Appraisal. *Global Urban Development Magazine.* Retrieved from http://www.globalurban.org/GUDMag08Vol4Iss1/Radoine.htm

Sendin, P. (2011, September 12). *The Medina of Fez: Analysis of a Superb Compact Town.* Retrieved from http://www.patriciasendin.com/2011/09/medina-of-fez-analysis-of-superb.html

Souames, F. (2011, March 17). *The maze city: the medina of Fez…Africa's Athens.* Retrieved from http://www.moroccoworldnews.com/2012/03/31801/the-maze-city-the-medina-of-fezafricas-athens-4/

Fes Medina Rehabilitation Project. (2009, September 9). Retrieved from http://web.worldbank.org/external/projects/main?menuPK=228424&theSitePK=40941&pagePK=64283627&piPK=73230&Projectid=P005524

Kairaouine Mosque, Fes (2009). Retrieved from http://www.sacred-destinations.com/morocco/fes-kairaouine-mosque

Moroccan Architecture (2009, December 14). Retrieved from http://www.yacout.info/Moroccan-Architecture_a994.html

The Moroccan Medina. (2002) Retrieved from http://www.carfree.com/fes/index.html

Electronic documents:

ESRI UK. (2009). *Masdar City: The world's first carbon-neutral city.* Retrieved from http://www.esri.com/industries/facilities-management/pdfs/masdar.pdf

Masdar. (2010, September) *Building The World's Most Sustainable City.*

Masdar. (2010, October). *Exploring Masdar City.* Retrieved from http://www.masdarconnect.com/userfiles/files/Exploring-Masdar-City-Site-Tour-Booklet.pdf

Masdar. *Masdar City: One day all cities will be built like this.* Retrieved from http://web.mit.edu/green_t/Public/Thesis/Cities%20Cases/Masdar/MASDAR.pdf

Masdar. *Masdar City: Project Development Overview.* (2009, February). Retrieved from http://www.usea.org/Programs/CFFS/CFFSDubai/DOE_Masdar_DevelopmentOverview_Feb09.pdf

Printed journal articles:

Gonchar, J., Nambiar, S. (2011). Masdar Institute. *Architectural Record, 2011/05,* 130-139.

Hartman, H., (2010). Masdar. *Architect's Journal, 11.02.10,* 24-33.

Murray, C., (2008). Abu Dhabi. *Architect's Journal, 30.10.08,* 21-33.

Books:

Kuma, K. (2008). *Anti-Object* (H. Watanabe, Trans.). London: Architectural Association

Gehl, J. (2010). *Cities for People.* Washington: Island Press